Object Engagement, Lexical Organization, and Word Learning in Children with Autism Spectrum Disorder: A Case Study

Undergraduate Research Thesis

Presented in Partial Fulfillment of the Requirements for graduation “with Research Distinction in Speech and Hearing Science” in the undergraduate colleges of The Ohio State University

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April 2016

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Introduction.

Autism is characterized by deficits in social communication in the presence of restricted repetitive behaviors (APA, 2013). According to the CDC autism spectrum disorders (ASD) affect 1 in 68 children (Network, 2014) and has an estimated lifetime per capita cost of 2.4 million dollars (Buescher, Cidav, Knapp, & Mandell, 2014). Language is one of the best predictors of outcomes (Howlin, 2000). Therefore, by improving language outcomes we can decrease the overall cost of ASD. A critical step in addressing this problem involves gaining insight into how language development overlaps and diverges from typical language development.

Delays in receptive and expressive language are observed in the majority of children with ASD (Eigsti et al., 2001, American Psychiatric Association, 2013). The delays observed in vocabulary development may be due, in part, to their failure to develop the shape bias, a word learning strategy used by typically-developing children (Tek et al., 2008). The shape bias is the tendency for children to extend labels for solid count objects on the basis of shape rather than other attributes, such as size or color (Smith, 2000). For example, children with a shape bias extend the label “ball” to beach balls, and tennis balls because they are both “ball” shaped (e.g., Smith, 2000). The shape bias is observed once toddlers have acquired approximately 50 words in their expressive vocabularies. As infants and toddlers spend more time with an object, they will extract important information about the object (Adolph, Eppler, & Gibson, 1993). A child’s ability to extract relevant information is linked to the ability to construct specific categories based on the objects attributes, such as shape. Category development allows the child to generalize the label of an object and organize these labels within their vocabulary (Smith, 2000). Emergence of the shape bias is associated with rapid vocabulary acquisition in typically-developing toddlers (Samuelson & Smith, 1999). This is because once children have a shape bias, they know they do not have to learn a new word each time they encounters a different ball, which enables children to efficiently categorize objects (Tek et al., 2008). Unlike typical language learners, children with ASD do not demonstrate a shape bias even after achieving 50 words in their vocabulary (Tel et al., 2008). This suggests that children with ASD do not organize words into abstract categories that support rapid vocabulary expansion and indicates a disassociation between word learning and lexical organization in children with ASD (Tek et. al, 2008). The current study seeks to investigate what underlies this disassociation by exploring the relationship between object engagement, word learning, and lexical organization in children with and without ASD.

A second factor for delayed category development in children with ASD is motor skills. Previous research indicates a relationship between fine motor skills and later receptive and expressive language development in children with ASD, with object engagement mediating this relationship (Hellendoorn, 2015). Children learn about objects by engaging with them (Yee, Chysikou, Hoffman & Thompson-Schill 2013). The impaired motor function ability well documented in children with ASD (e.g., Bhat et. all, 2011) may negatively influence development of the shape bias since fine motor skills facilitate a child's interaction with an object. That is, a child with more developed motor skills will have a more successful interaction with an object (i.e., be able to manipulate the object in a variety of ways), which may result in extraction of relevant semantic deatils about the object. Adversely, a child who has poor fine motor skills may not be able to interact with the object as adeptly, which does not allow the child to extract all of the semantic features of the object (e.g. size, shape, texture, etc.). In addition to the delays in fine motor skills, which may be impacting children's development of the shape bias, children with ASD also demonstrate atypical object engagement such as fixating on one aspect of an object (e.g. spinning the wheels of a car and disregarding all other features of the object) (Baranek, 1999). This atypical object engagement alters what information a child extracts from an object. More specifically, if children fixate on one aspect of an object (e.g., the wheels of a car) they will not extract relevant information about other aspects of the object that are relevant for learning and lexical organization (e.g., shape). This atypical play behavior may lead to ineffective object categorization, which, in turn, hampers the emergence of the shape bias.

The present research study investigates the relationship between object engagement, word learning, and lexical organization to further understand whether the disassociation between lexical organization and vocabulary observed in children with ASD is due to atypical object engagement. The expected outcomes are threefold. First, I predict that the child with ASD will be a poorer word learner than their TD peer. Second, I predict that the child with ASD will not demonstrate a shape bias; however I do expect there to be variable performance within the ASD on the basis on motor skills**.** With regard to the child with ASD, I predict a relationship between object engagement and the shape bias. More specifically, I predict that the child with ASD who engages in more atypical play with the objects will be less likely to show a shape bias, whereas children with ASD who engage in more typical play will be more likely to show a shape bias.

Methods

Participants. Participants were recruited through local businesses, childcare providers, and applied behavior analysis (ABA) service providers throughout the Columbus area and surrounding communities. Flyers were distributed throughout the community. Participants were volunteers who had followed up with the flyers.

One typically-developing child age 2 years, one child with ASD age 4 years and 8 months, and one child with a language impairment age 2 years participated in this study. The participant with ASD had an autism diagnosis prior to entry into the study. The diagnosis was confirmed with the *Autism Diagnostic Observation Schedule (ADOS*) on a previous visit to the lab (Lord et al., 2000). The TD subjects had no history of speech or language delays and scored within the normative mean and standardized assessments of language and cognition. The language-impaired subject had language scores that fell two standard deviations below the normative mean and cognitive scores that fell within the normative mean. The typically developing and language impaired participants were matched to the participants with ASD on the basis of expressive language via the *Mullen Scales of Early Learning.* See table 1 for a detailed description of the participants (Mullen, 1995).

Figure 2. Participants

Child	Age	Receptive (Raw)	Expressive (Raw)	Non-verbal IQ (Raw)	Receptive (Standard)	Expressive (Standard)	Non-verbal IQ (Standard)
ASD	4.8	17	18	26	*	*	*
TD	2	24	17	34	46	26	68
LI	2	13	13	22	20	25	38

Note: ASD, autism spectrum disorder; TD, typically developing; LI, language impaired.
*Scores could not be calculated.

Materials

Standardized Assessments. The *Mullen Early Scales of Learning (MESL)* was administered to assess the child's receptive, expressive, and non-verbal cognition. The MESL is a comprehensive assessment of a child's visual, motor, visual reception, and fine motor skills. This is a valid assessment for children ages birth to 68 months.

The *Autism Diagnostic Observation Schedule* (Lord et al., 2000) was administered to participants with ASD to confirm the diagnosis. The ADOS is an assessment to elicit and observe behaviors that are associated with an ASD diagnosis including the following: communication, social interaction, and restricted and repetitive behaviors. The ADOS is widely used to determine an ASD diagnosis (Chawarska, Klin, Paul, & Volkmar, 2007).

Experimental Task:

The experimental task consisted of a familiarization phase, followed by direct testing as well as a label extension task. See Figure 2 for a progression of the experimental task

Figure 2.

Familiarization			Direct Testing		Extension
Introduction to the dax Duration: 1 minute	Introduction to the toma Duration: 1 minute	Play with familiar objects Duration 5 minutes	Expressive testing: "Look! It's a __"	Receptive testing: "Can you put the baby in the bucket?"	Short video assessing the use of shape bias via eye gaze.

Familiarization. First, the child was introduced to two novel objects, which were labeled as a "dax" and "toma". Each toy was introduced separately. After the initial labeling (i.e., "Look it's a____"), the child was given one minute to play with the toy. During this time, the researcher named the object nine more times. The researcher repeated the following phrases twice: “This is a *toma*. Look! It’s a *toma*. See the *toma*? There’s the *toma*. Wow! Look at the *toma*.” After each novel object had been named and the child had played with it individually for a minute, the child was given five minutes to play with the novel objects as well as four familiar objects (e.g. baby, bottle, spoon, and blocks). The novel and familiar objects were named as the researcher pulled them out of a bin and placed them on the table in front of the child. After all of the items were placed on the table, the child was encouraged to play with the objects. After five minutes, the researcher tested the child’s receptive and expressive knowledge of the novel objects.

Testing. Both expressive and receptive language testing was completed immediately after the child finished playing with the objects. Expressive language testing was always followed by receptive language testing.

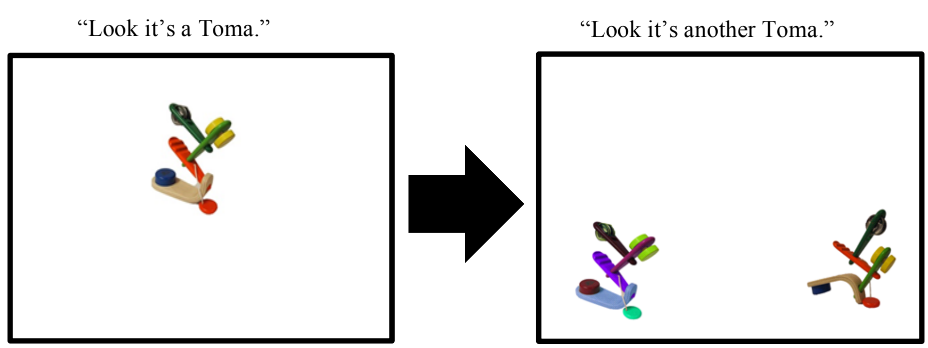
<u>Expressive language testing</u>. For the expressive testing, the child was asked to fill in the sentence and label the object (e.g. Look! It’s a … (pause)). The researcher first did this with familiar objects so that the child could learn the task. After naming the familiar objects, the researcher tested expressive naming of the novel objects. If the child did not produce the names of the novel objects the examiner named them.

<u>Receptive language testing</u>. Following the expressive task, the receptive vocabulary was tested. The child was first asked to place the familiar objects in a bucket (e.g “Can you put the *baby* in the bucket?”) Then the child is asked to place the novel objects in the bucket (three novel objects were present, the dax and toma as well as a control novel object).

Label Extension. A preferential-looking task was used to determine whether the child extended labels on the basis of shape or color. The child watched a short video.

The video showed six total familiar objects paired together and the two novel objects. Photographs of the stimuli were coupled with the auditory prompt "Look! It's a (name of one of the items on the screen e.g., *dax*)!" while the screen shows both a *dax* and a *toma*). To assess extension a photograph of the novel object was presented with the accompanying audio "Look it's a toma." Then, two objects, which differed on the basis of shape or color, were presented with the accompanying audio, "Look there's another *toma.*" The shape-matched object differed in color, but was the same shape as the original object. The color-matched object differed in shape, but was the same color as the original object. If the child recognized the object based on the shape match, that child was known to use the shape bias. If the child recognized the object based on the color match, the child did not show use of the shape bias. To indicate recognition, the child would look and/or point at the object. See Figure 3 for a more detailed description of shape and color match.

Figure 3.



Coding.

Object engagement coding. Coding for the play portion of the experimental task was completed in The EUDICO Linguistic Annotator (ELAN) (Hellwig & Van Uytvanck, 2003). Each time the child touches the object the type of interaction will be coded. The interaction can be labeled as engagement (purposeful play), looking at the object (not purposefully play but taking in the qualities of the toy), passive engagement (having the toy in the hand but the child's attention is elsewhere), symbolic engagement (using the bottle to feed the baby), or throwing. ELAN coding software will allow for the child's engagement in each category to be totaled. These values will be analyzed and compared to indicate how the child is engaging with objects. See Table 4.

Table 4. Object engagement coding categories.

Category	Looking	Engaging	Passive	Symbolic	Throwing
Definition	Not purposefully playing with the object, but taking in the qualities of the toy.	Purposeful play.	The child has the object in the hand but their attention is elsewhere.	Using two objects to recreate figurative play.	The child intentionally throws the object.
Example	Starring at the toma.	Playing with the cymbals of the toma.	Child holds the toma in one hand but is focused on the spoon.	Child uses the spoon to feed the baby.	Grabbing the dax and forcefully throwing it.

Receptive and Expressive Word Learning Scoring:

A child succeeded in expressive identification of the object if he or she verbally named the object correctly. Familiarization of the task was done prior to the test trials with familiar objects. The child was prompted to name the object (e.g. "Look! It's a… (pause) baby"). Success in the receptive testing was met if the child chose the appropriate object when prompted to put a specific toy in the bucket. The child was given three options during receptive testing. Each option was a novel object. (e.g. Can you put the dax in the bucket?"

Extension Coding. Coding for the label extension task was collected and analyzed by using an eye coding software, Icoder. This software allows for a frame-by-frame analysis of the child's eye gaze.

Results

Preliminary data from three participants indicated three different object engagement patterns amongst participants. See Tables 5,6, and 7– for a summary of the child's object engagement coding. See table 8 for a summary of the child's direct testing and label extension The typically-developing child spent the majority of the allotted play time engaged in symbolic play. She spent an equal amount of time engaging with the toma and dax, showing no preference for one object over the other. During direct testing, the child receptively identified both novel objects. During the label extension task, the child extended the labels for both novel objects on the basis of shape, indicating the presence of a shape bias.

In contrast, the child with language impairment did not engage in any symbolic play. The child spent the majority of the play time engaged with the toma. However, he was unable to receptively or expressively identify the novel objects. During the label extension task he did not extend on the basis of shape.

Similar to the LI child, the child with ASD did not engage in any symbolic play. He spent the majority of the play time engaged with one object, the toma. As predicted, his object engagement different from the TD child. In direct testing, he did not expressively or receptively identify any of the novel objects. Unlike the child with language impairment, the child with ASD extended the label of the toma based on shape, indicating the presence of a shape bias for his label extension of the toma.

Table 5. Child's interactions with familiar objects

Child	Looking	Engaging	Passive	Symbolic	Throws	Total Duration
ASD	15.69	38.48	24.71	0	0	78.88
TD	4.35	0	12.52	139.22	0	160.87
LI	2.2	3.95	5.3	0	0.25	11.7

Table 6. Child's interactions with the toma.

Child	Looking	Engaging	Passive	Symbolic	Throws	Total Duration
ASD	42.23	68.74	16.93	0	0	127.9
TD	24.22	32.09	35.57	0	0	91.88
LI	25.52	288.35	20.3	0	0	334.17

Table 7. Child's interactions with the dax.

Child	Looking	Engaging	Passive	Symbolic	Throws	Total Duration
ASD	23.97	12.56	23.52	0	.92	60.98
TD	16.41	30.04	9.56	0	0	56.01
LI	10.3	32.36	2.91	0	0	45.54

Note. Total Duration is indicative of 2 one-minute introductions and 5 minutes of free play.

Table 8. Direct testing and label extension results.

Child	Direct Testing				Label Extension (percentage of time looking at shape match)	
	Receptive		Expressive		Receptive	
	Dax	Toma	Dax	Toma	Dax	Toma
ASD	No	No	No	No	-	.81
TD	Yes	Yes	No	No	.63	.68
LI	No	No	No	No	.45	.53

Discussion

This study investigated the relationship among object engagement, word learning, and lexical organization. In this study we compared the performance of three children during a word learning task, one typically-developing child, one child with ASD, and one child with a language impairment. These children were matched on the basis of expressive language to compare their word learning strategies. Findings indicate that the typically-developing child was an efficient learner. She spent little time with the novel objects, yet was still able to extract relevant information from the objects to create word-referent pairings and categorize the semantic features of the objects (as demonstrated by her consistent extension of labels on the basis of shape). Contrary to my hypothesis, the child with ASD did demonstrate a shape bias. I speculate that the presence of this shape bias may be attributed to two factors. First, the child's age (4 years 8 months) may have influenced his ability to demonstrate a shape bias. This child was nearly five years old, which is almost 2 years older than the children in Tek et al.'s (2008) study. Therefore, it is possible that over the course of development he acquired a shape bias and that children with ASD demonstrate a shape bias after they achieve much larger vocabularies. However, this hypothesis is less likely given that he did not demonstrate the shape bias for both objects. Secondly, the ability to demonstrate a shape bias was influenced by how the child engaged with the object. There is a known tendency of children with ASD to fixate on one object or one aspect of the object. It is possible that the child's obvious interest in one of the objects facilitated his ability to extract relevant information from the object and utilize the shape as a cue for categorizing this particular object. Evidence for this possibility comes from the fact that when the child was uninterested in the object (e.g. the dax) the child is unable to extract relevant information from the object and will not succeed in developing the shape bias.

Similar to the participant with ASD, the language impaired participant was not able to extract relevant information from the novel objects. Of the three participants, the language impaired participant spent the most time engaging with the objects. However, like the child with ASD, he was unable to extract relevant semantic information from the novel objects to create a shape bias. This child showed no evidence of a word-learning strategy and failed to identify the novel objects using the shape bias.

Taken together, these finding suggest that object engagement may influence the relationship between lexical organization and vocabulary. The typically developing participant showed efficient object engagement, which led to proper organization of semantic details of the object. The child with ASD was able to extract semantic details from the object when interested in the object, and allotted additional time to engage with the object. While the child with ASD was able to selectively utilize the shape bias, the child with language impairment was unable to extract any relevant semantic details from the novel object even when allotted extensive time with the object. While both the child with ASD and language impairment had increased engagement with the toma, they way in that they engaged with objects differed. The child with ASD physically manipulated the toma in a way that enabled him to extract information about the object. In contrast, the child with language impairment frequently engaged with the object in a way that did not require physical manipulated. Thus, he was unable to extract relevant information about the shape of the object, which hindered his ability to develop a shape bias.

This finding suggests that there may not be an atypical object engagement pattern that yields a poorer organization of a child's vocabulary. Future research is needed to better understand the different object engagement patterns that influence learning.

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